Potential transport transfers to domestic water traffic

Finnish Maritime Administration
Waterways Department

Finnmap Oy
Traffic Department

1 November 1991

INDEX

ABSTRACT

The aim of the work was to study the effect on the distribution of labour between the different modes of transportation when the waterways transport option was taken into consideration. The work was done on the basis of the goods traffic report made for the second parliamentary Traffic Committee. The 1987 statistics for road traffic truck goods flow were used as the starting point.

Of the total annual volume of goods transported by truck (405 million tonnes), the research work studied about 62 million tonnes. These were such goods flows that could theoretically be transported also by water or rail, so-called theoretic potential. Nine different categories of goods were studied in the goods traffic report done for the Traffic Committee (the theoretic potential was about 80 million tonnes per year). This work included five of these categories, i.e. gravel and sand, wood raw materials, forest industry products, mineral products and metal products.

Of the 62 million tonnes, the potential transfer to railway and waterways transportation was sought using the transportation model STAN, developed for the planning of goods transportation. Of this amount, the model allocated about 3.6 million tonnes for waterways and about 5.5 million tonnes for railways, or a total of roughly 9 million tonnes. The corresponding amount transferred to railways in the goods traffic report done for the Traffic Committee was about 6.4 million tonnes. Therefore, taking the waterways traffic into consideration as its own mode of transportation increases the goods volume from truck transports to the other modes of transportation, based on the cost of transport, by about 2.6 million tonnes per year, but decreases the amount transferred to the railways by about a million tonnes per year.

Due to the transfer of 3.6 million tonnes, the waterways transport amounts would increase by just over 400 million tonne kilometers per year, or by about 10%. The majority of the goods volume transferred to the waterways, about 3.2 million tonnes, would be raw wood.

The report indicates that the waterways and railways are competing from the same goods flows only in raw wood transports. The raw wood amounts transferred from trucks to the railways would be about 1 million tonnes less annually due to timber floating. If only the barge transports - and not floating - would be considered as the waterways transport, the volume of raw wood transferred from trucks to the railways would not decrease at all according to the STAN model. Under this type of transportation arrangement, about 0.23 million tonnes per year would transfer from trucks to barges, based on the cost of transport.

The sensitivity of raw wood transports to possible fluctuations in the costs of launching the raw wood into the water was studied by changing the current unit costs -30% and +30% in the transportation model STAN. According to the results, this did not have any significant influence on the raw wood transport's distribution between the different modes of transportation.

1. INTRODUCTION

The second parliamentary Traffic Committee's goods traffic report, called "The division of labour in goods traffic", dealt with the current division of labour of Finland's goods traffic and the transfer and replacement possibilities of the different modes of traffic. The work also included an analysis of Finland's current goods traffic and its divisions of labour with respect to the mode of transport, category of goods and transport distance. The estimates on the transfers of goods transports from truck to railway were made based on the statistical material for road traffic goods transportation.

The waterways transport option as its own mode of transportation was not taken into consideration when estimating the transfers of the goods transports in the goods traffic report done for the Traffic Committee.

This work clarifies the effect on the distribution of labour between the different modes of transportation when the waterways transport option is taken into consideration. The work utilizes the same initial information for truck and railway transportation as in the Traffic Committee's work.

The Finnish Maritime Administration commissioned the work, and its participants were Chief Engineer Keijo Kostiainen, M.Sc. Risto Lång, Researcher Jukka Valjakka and engineering student Olli Holm. The consulting firm was Finnmap Oy and its Project Manager Erkki Jaakkola and Project Engineer Esa Parjanen.

2. STARTING POINTS

2.1 General

The starting points for estimating the transfers between different modes of transportation were the goods transports by truck in Finland. Goods transports currently made by railway or waterway are not dealt with in this report.

In the goods traffic report made for the Traffic Committee, the current (1987) truck transports were analyzed and filtered. What remained after the filtering was the so-called theoretic potential, which could be considered as also carried by railway. The theoretic potential, a total of about 80 million tonnes, was allocated by goods categories to the optimum road and railway networks based on the cost of transport.

This work studied the allocation of the theoretic potential amounts of corresponding goods categories to the transportation networks under circumstances that include also the inland waterways and coastlines. Choosing the optimum transportation route was done based on the cost of transport. The goods transportation model STAN was used in the calculations.

Chapter 3 contains more details about the base data, transportation networks, goods flows and costs of transport used in the study.

2.2 Goods transports in Finland

2.2.1 Transport volumes and tonne kilometrage

In 1990 a total of 500 million tonnes of goods were transported by truck, train and water in Finland. The corresponding tonne kilometrage was approximately 37 billion tonne kilometers. The distribution of the goods transports between the different modes of transportation from 1985 to 1990 is shown in figures 1 and 2.

The overwhelming majority of Finland's goods transports are made by truck. From 1985 to 1990 truck transports increased from about 370 million tonnes to over 455 million tonnes (23%). During the same period, tonne kilometrage increased about 5 billion tonne kilometers (24%). The ratio of truck transports to all goods transports also increased slightly, from about 89% to 91%.

Rail transports (excluding transit traffic) have fluctuated from 27 million tonnes to 33 million tonnes. The rail transports share of the goods transports has remained nearly constant at about 7%. During recent years, the rail transports share of the goods transports tonne kilometrage has been about 21%.

Waterway transports in Finland have decreased from about 15 million tonnes in 1985 to about 12 million tonnes in 1990. The waterway transports share of all the goods transports in Finland is currently just over 2%. The waterway transports tonne kilometrage is about 4 billion tonne kilometers annually. This is about 11% of the tonne kilometrage of all goods transports.

2.2.2 Transport distances

The average transport distances between the different modes of transportation have developed from 1985 to 1990 as shown in Table 1.

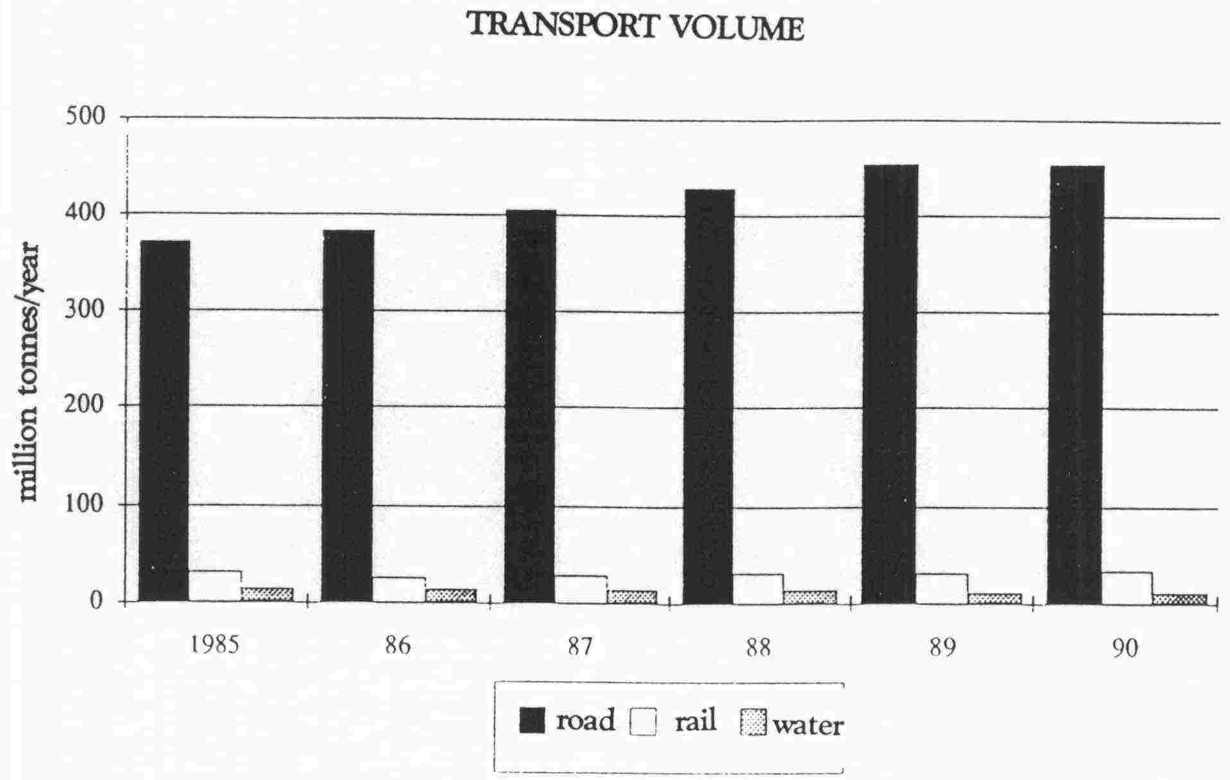


Figure 1 Transport volumes of different modes of transportation, 1985-1990

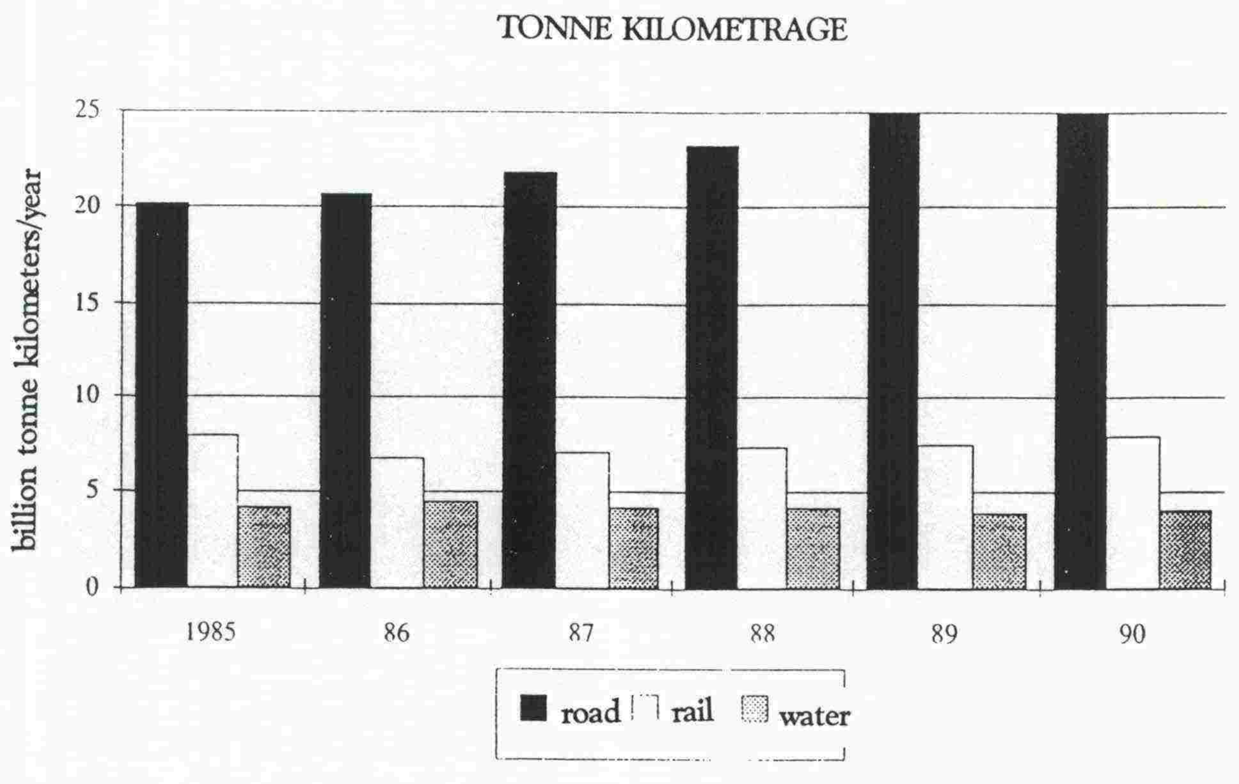


Figure 2 Tonne kilometrage of different modes of transportation, 1985-1990

Table 1 Average transport distances (km) of different modes of transportation, 1985-1990

	1985	1986	1987	1988	1989	1990
road	54	54	54	54	55	55
rail	263	248	245	231	234	239
water	280	300	280	315	325	333

During the period under examination, the average transport distance for truck transports has remained at about 54 km. Rail transport distances have shortened by about 20 km, and waterway transport distances have increased an average of 50 km. The transport distances of waterway transports are longer than with the other modes of transportation.

3. GOODS FLOW STUDY

3.1 General

A computer model STAN, designed for goods transport planning, was used to allocate goods flows on the transportation networks. The model takes into consideration as base data the transportation networks representing the transportation connections, the interchange terminals between the different modes of transportation, the factors influencing the selection between the transportation mode and route as costs, and the volume of goods by product between the point of departure and the destination.

The STAN model optimizes the entire transportation system, i.e. it allocates goods flows in the most economical way to the studied transportation routes and modes according to all the factors included affecting the selection of the transportation route.

In practice, the most important factors influencing the choice of the transportation mode are usually delivery reliability, the cost of transport, and delivery speed. The relative weight of the cost of transport in the decision-making process of selecting the mode of transportation is more than 50%. The goods traffic report made for the Traffic Committee also includes other factors that have a practical effect on the selection of the transportation mode.

The only factor included in this work influencing the choice of the transportation mode and route was the cost of transport.

3.2 Base data

3.2.1 Transportation networks

With the goods flows under study in this work it was possible to "use" road, rail or water transports. In this work the goods flow transfers between the different modes of transportation was possible in all the Finnish State Railways station locations, water launching sites and barge loading and unloading sites, and ports considered important for goods transportation.

The road network used is based on the road register of Road Office's main, connecting and regional road network. The main roads of cities were added to this.

The railway network used is the entire nationwide railway network of importance to goods transportation.

The waterways network used includes the current inland and coastal log floating network and the network suitable for barge transportation. Included in the studies was also the channel currently being constructed between the Keitele and Päijänne lakes. The loose log floating waterway of the Kemijoki river was also included in the network information. Separately depicted in the STAN model were all locks and bundle transfer sites, barge loading and unloading sites, and log floating launch sites. A diagram of the transportation networks used is presented in Appendix 1.

3.2.2 Goods flows

The truck traffic goods flow information used is based on the Road Office's "Statistics of goods transports by road". After analyzing and filtering the goods flow statistics, the remaining potential goods category-based goods flows were used as the base data in the STAN model. The filtering of statistical information was done in conjunction with the goods traffic report made for the Traffic Committee. The principles of filtering are presented in the Ministry of Transport and Communication's publication 9/91 "Division of labour in goods traffic".

The above-mentioned potential goods flows are those currently truck-transported goods flows, the nature of which makes them also suitable for rail transport. The goods categories presented in Table 3.1 were selected from the potential goods flows for studies in this work. A more specific itemization of the goods categories is presented in Appendix 2. The nature of these goods categories makes them suitable also for waterway transport. The goods flows were handled as a goods flow from one county to another.

Table 3.1 Goods categories and their total volumes (million tonnes/year) studied with the STAN model

Goods category	Transport volume
Gravel and sand	9.89
Wood raw materials	26.18
Forest industry products	10.45
Mineral products	10.11
Metal industry products	4.89
Total	**61.52**

In raw wood transports, the transportation time and quality requirements restricted the selection of the transportation mode. For example, water floating is not a suitable mode of transport for all species of trees. In this work it is presumed that half of the amount of potential raw wood is such that can be transported by floating. Furthermore, it is presumed that all of the logs suitable for floating can be transported during the floating season.

3.2.3 Cost of transports

The transport costs used are split into the actual transport costs, loading and unloading costs, and costs incurred by the transfer between the different transportation modes. These figures were each presented separately in the STAN model. The costs were those expenses the shipper, i.e. the customer, would have to pay for each phase of transportation and handling. The 1989 price level was the cost level used.

For truck traffic and railway traffic, the costs were identical to those used in the work done for the Traffic Committee.

In waterway transports, separate expenses were defined for loose and bundled log floating, and for barge transports. The floating expenses are based on the actual cost data by watercourse in accordance with floating association reports. The barge transport expenses are based on actual transports by motor barges. The expenses included the loading and unloading costs, the barge down-time expenses, and the actual cost of transport for each goods category.

In the truck transport expenses, the added costs incurred in trucking for log floating were taken into consideration. These expenses were caused by the smaller load capacity and more expensive equipment standards.

As was mentioned in the goods transportation report done for the Traffic Committee, the accuracy of the cost data (factors) for the goods categories presented above can be considered mainly as directional. One of the reasons for this is that individual types of goods within a goods category generally have different transport costs because of the different kinds of transport equipment or loading and unloading methods. In practice, the cargo naturally varies also within the goods category and in different parts of the country.

Studying the selection of the transportation route solely on the basis of cost of transport will not give an accurate picture of the most "economical" transportation routes. As a result, however, those areas where competition would exist between different modes of transportation if the starting point were only transport costs become clear.

3.3 Allocation results

Table 3.2 presents the potential truck transport volumes included in the study by goods category, as well as the amounts of goods from these volumes allocated to the road and waterways networks under the STAN model. The table also presents the amounts of goods which, on the basis of the Traffic Committee's work, were allocated to the rail network if the only possible transportation modes were the road and railway networks (PARLA). The results are illustrated in figures 3 and 4, and in the goods flow allocation graphics in appendices 3-6. Table 3.3 presents the tonne kilometrage of different modes of transport in corresponding transport network situations.

Table 3.2 Volumes (by goods category) allocated from the theoretic potential to the waterway and railway networks according to the STAN model (million tonnes/year).

Goods category	Theoretic potential	To waterway network	To rail network 1	To rail network 2 (PARLA)	Rail network difference 2-1
Gravel	9,89	0,14	0,57	0,57	0
Wood raw mat.	26.18	3.30	3.14	4.10	0.96
Forest. ind. prod.	10.45	0	0	0	0
Mineral products	10.11	0.14	1.05	1.05	0
Metal products	4.89	0.02	0.69	0.69	0
Total	**61.52**	**3.60**	**5.45**	**6.41**	**0.96**

Table 3.3 Tonne kilometrage for transferring transport volumes on waterway and railway networks, million tonne km/year

Goods category	On waterway network	On rail network 1	On rail network 2 (PARLA)	Rail network difference 2-1
Gravel	14	102	102	0
Wood raw mat.	337	678	868	190
Forest. ind. prod.	0	0	0	0
Mineral products	52	323	323	0
Metal products	11	327	327	0
Total	**414**	**1 430**	**1 620**	**190**

Based on the results, transfers from truck transports to other modes of transportation would increase from the effect of waterways traffic by about a total of 2.6 million tonnes per year. Of the current approximately 62 million tonnes of truck transports under study, the STAN model allocates a total of about 3.6 million tonnes, or about 6%, to the barge and floating networks. The model would allocate a total of about 5.5 million tonnes, or about 9%, to the railways. According to the goods traffic report done for the Traffic Committee, the corresponding amount on the part of the five goods categories under study that would be transferred to the railways was about 6.4 million tonnes, or about 10%.

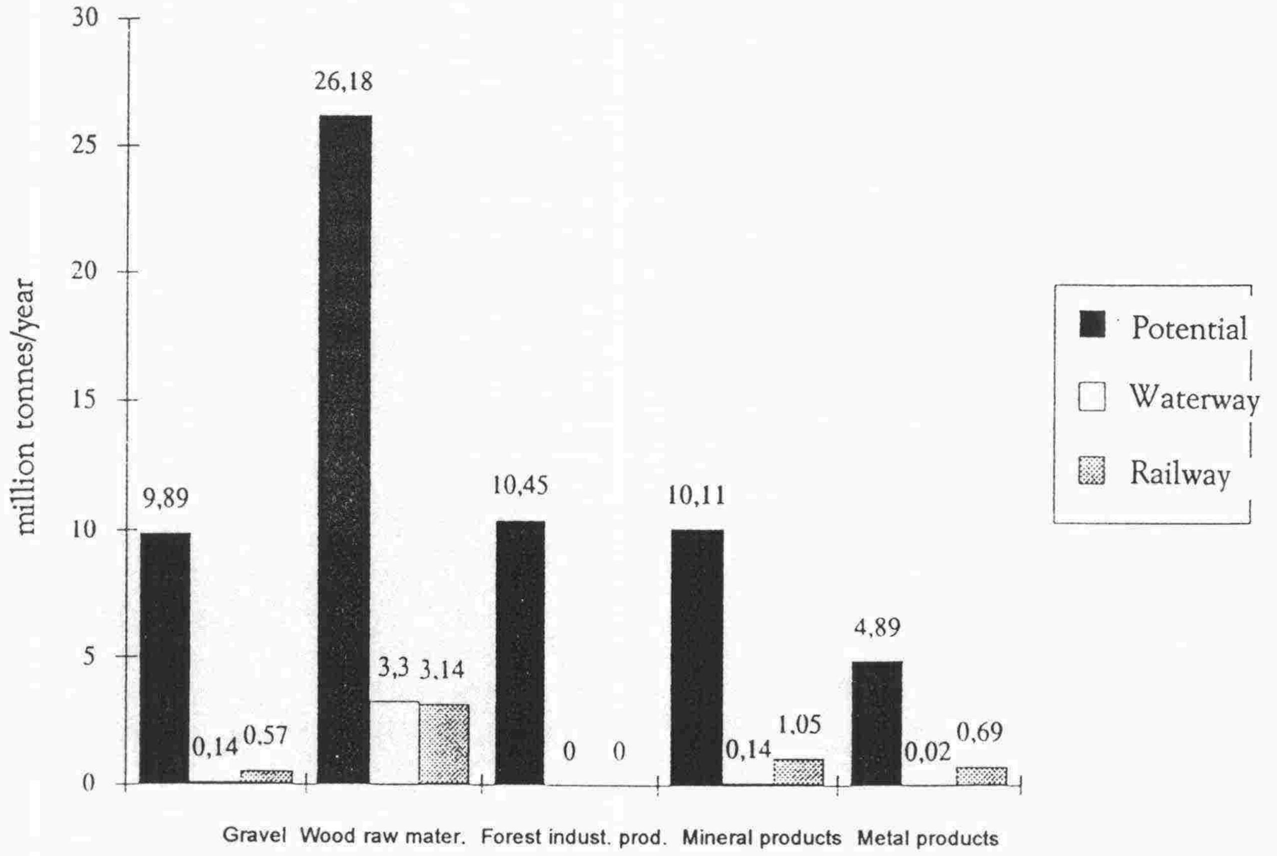


Figure 3 Theoretic potential and the amounts transferring to waterway and railway networks according to the STAN model.

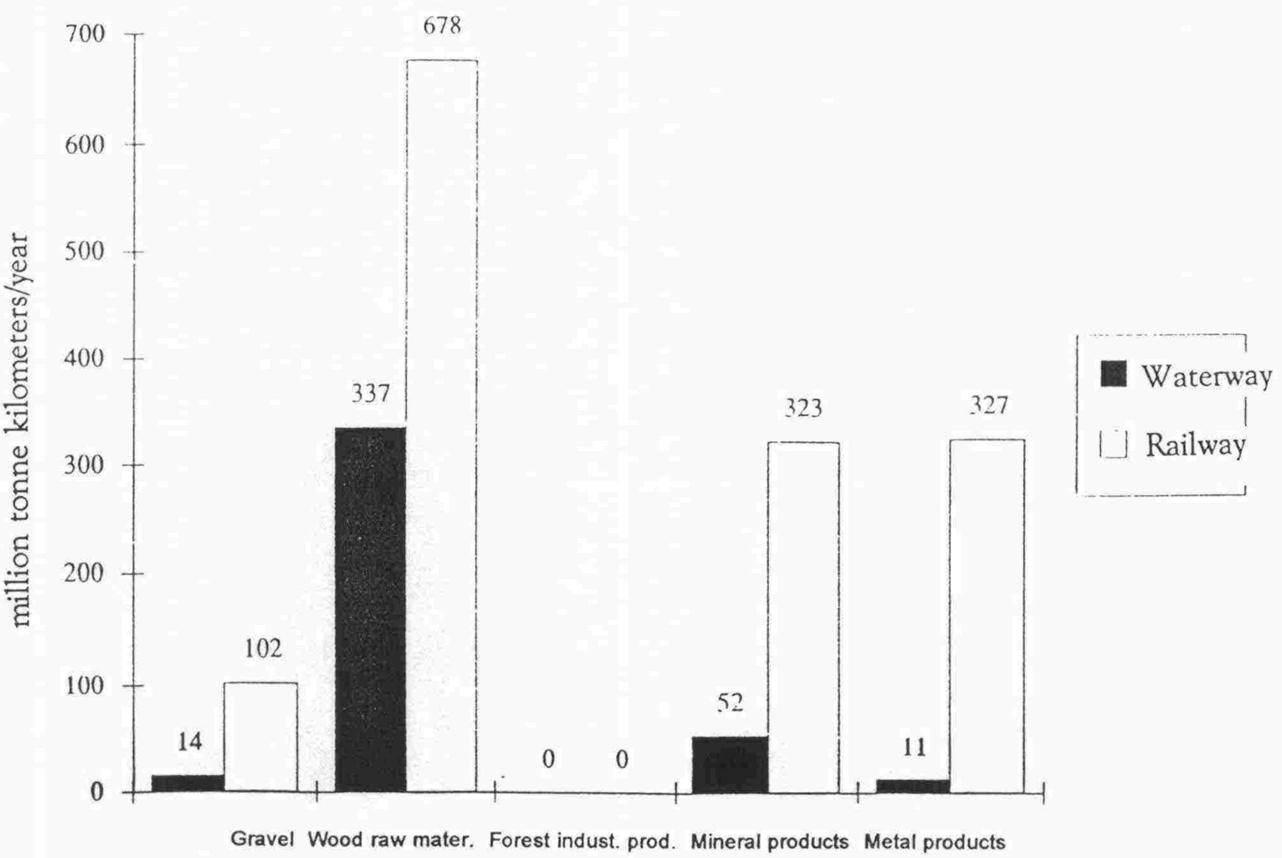


Figure 4 Tonne kilometrage of the transferring goods volumes on the waterway and railway networks.

Based on the results, taking waterways transportation into consideration would have only a minor effect on the transport volumes being transferred from truck to railway transport. The effect would be less than a million tonnes per year, and it would only impact raw wood transports. Allocations of these raw wood transports is illustrated in Appendix 3/3.

The model allocated the largest amount, i.e. about 3.3 million tonnes, from the current truck transports to waterway transports in the wood raw materials goods category. The majority of this, about 3.2 million tonnes, was allocated to floating; only about 0.1 million tonnes was allocated for barge transport. This is due to the fact that floating is possible nearly everywhere barge transportation is, and floating raw wood is almost always more economical than transporting by barge, based on transport costs. The volume of potential wood raw materials transferring to waterway transportation would be about 13%.

For other goods categories, the transport volume allocated to waterways transport is quantitatively and proportionately significantly smaller than for wood raw materials. According to the model, none of the forest industry products would transfer to the waterway and railway networks, calculated with the current cost level, even though in theory the potential would be about 10 million tonnes per year. This indicates that in the prevailing transportation system, forest industry product transports are already allocated in the most economically feasible way.

3.3.1 Sensitivity studies

The sensitivity studies examined how possible changes in water launch expenses would effect the transportation mode distribution for wood raw materials. The model calculated transport situations in which water launch costs decreased 30% from the current level and also increased 30%.

According to the results, changes in the water launch expenses would have hardly any impact on the transportation mode distribution with wood raw materials. This can be explained by the fact that based on the base data, the transportation model "centralizes" the wood flows to the same water launch sites, which keeps the water launch unit costs low, and its impact on the total cost of the transportation route is minor. In the model, the water launch expenses were dependent on the transport volumes: as the volume increases, the unit costs decrease.

4. ESTIMATES OF POTENTIAL TRANSFERS TO WATERWAYS AND RAILWAYS

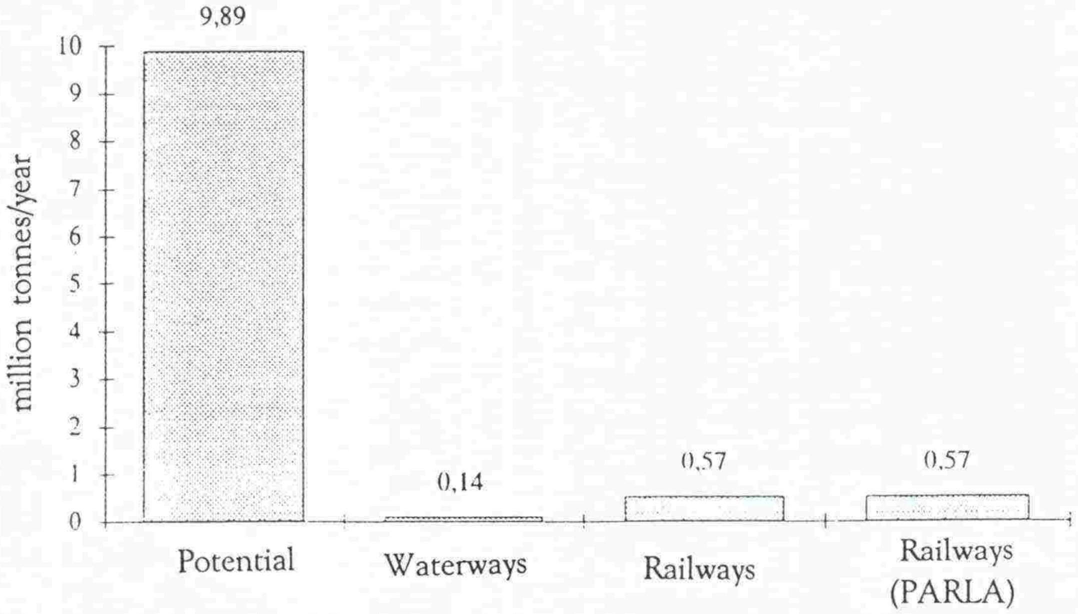
Of the current theoretic potential of 62 million tonnes transported by truck, the transportation model STAN allocated a total of about 3.6 million tonnes to waterway transportation and about 5.5 million tonnes per year to the railways. The allocations were made on the basis of the estimated cost of transport (prices) incurred to the transportation user. Taking waterway transports into consideration decreased the amount transferred to the railways by about 0.9 million tonnes per year.

Transferring 3.6 million tonnes to waterway transportation would increase the current waterways transportation tonne kilometrage by about 414 million tonne kilometers, or 10% per year. The average transport distances of water traffic would decrease about 50 km.

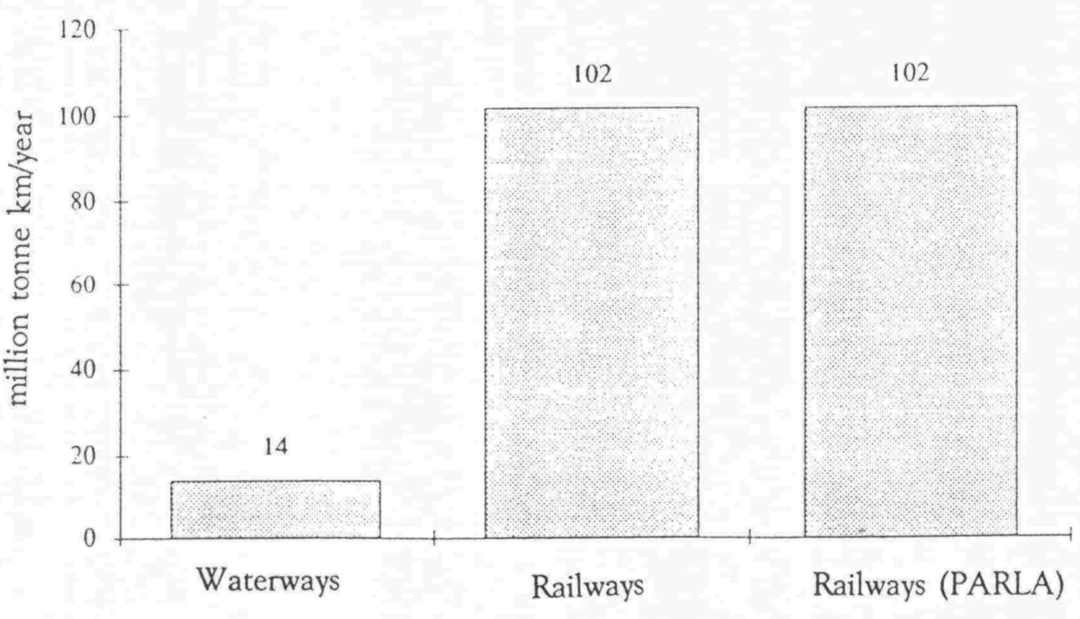
4.1 Studies per goods category

The following examines the results by goods category. The transport volumes and tonne kilometrage according to the different transport network situations for each goods category are illustrated. On the transport volumes, the illustrations represent the so-called theoretic potential, i.e. those currently truck-transported goods, the nature of which theoretically makes them also suitable for rail or water transport. Also presented are those volumes that, according to the STAN model, would be allocated from the theoretic potential to the waterways and railways when the current transport expenses are used as the starting point. The illustrations also show those transport volumes that, according to the goods traffic report done for the Traffic Committee, would be allocated to the railways if the water transport option is not included in the study.

TRANSPORT VOLUME

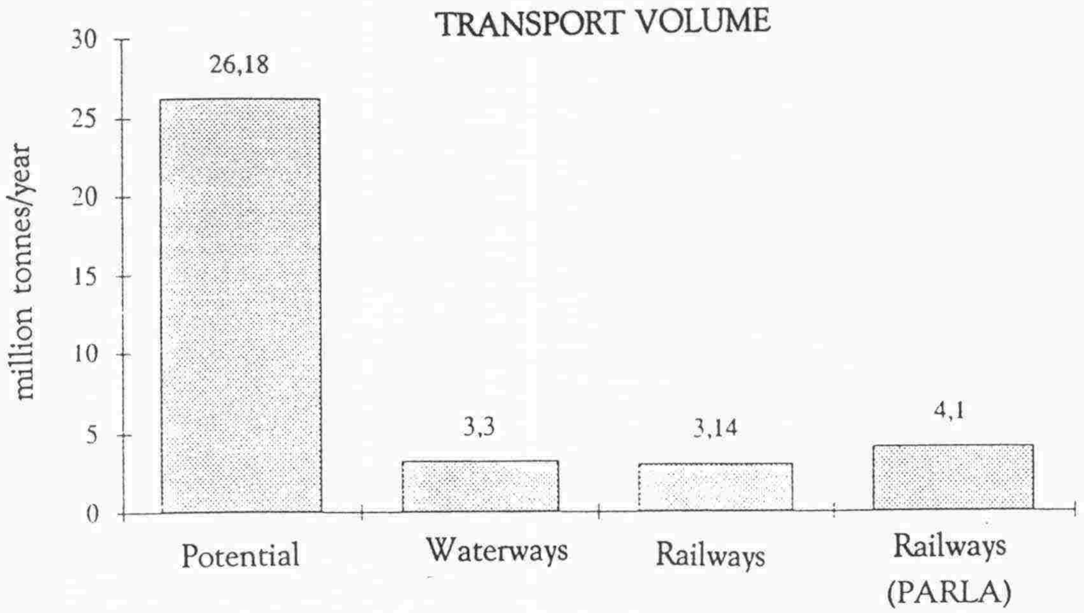


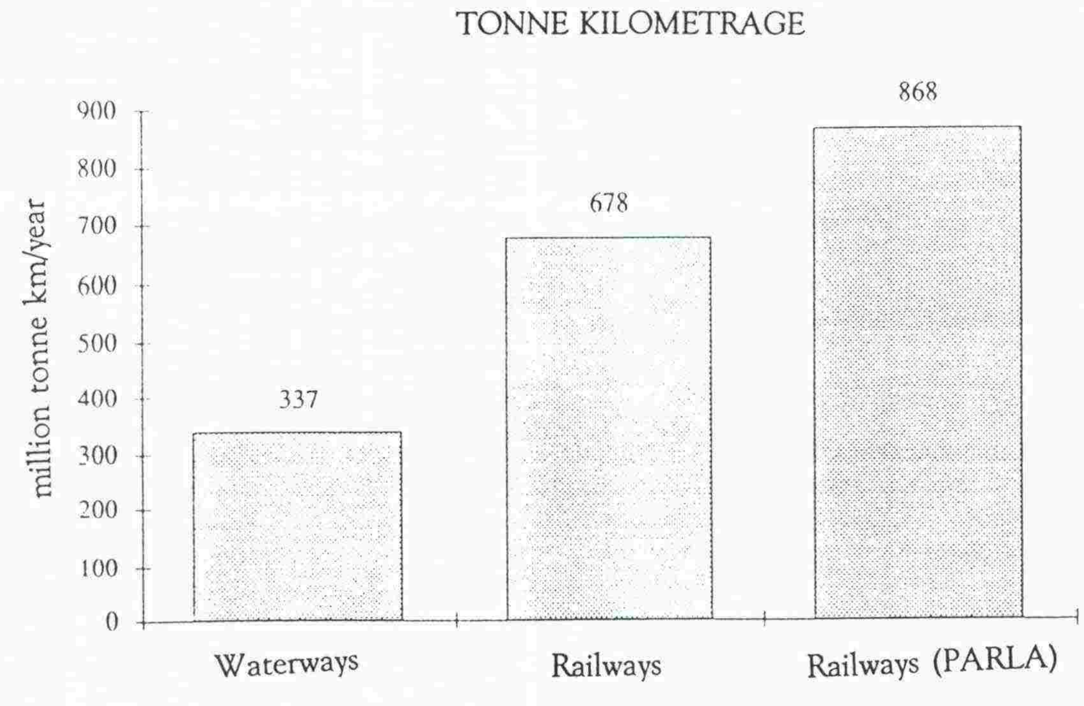
TONNE KILOMETRAGE



Gravel and sand

Of the approximately 10 million tonnes of theoretic potential, the model would allocate about 14,000 tonnes to barge transports and 570,000 tonnes to the railways. Taking the waterways transport option into consideration would not decrease the goods volume transferring to the railways on the basis of the cost of transport. The gravel volumes suitable for barge transport are on the coast between Vaasa-Pori and Helsinki-Kotka.



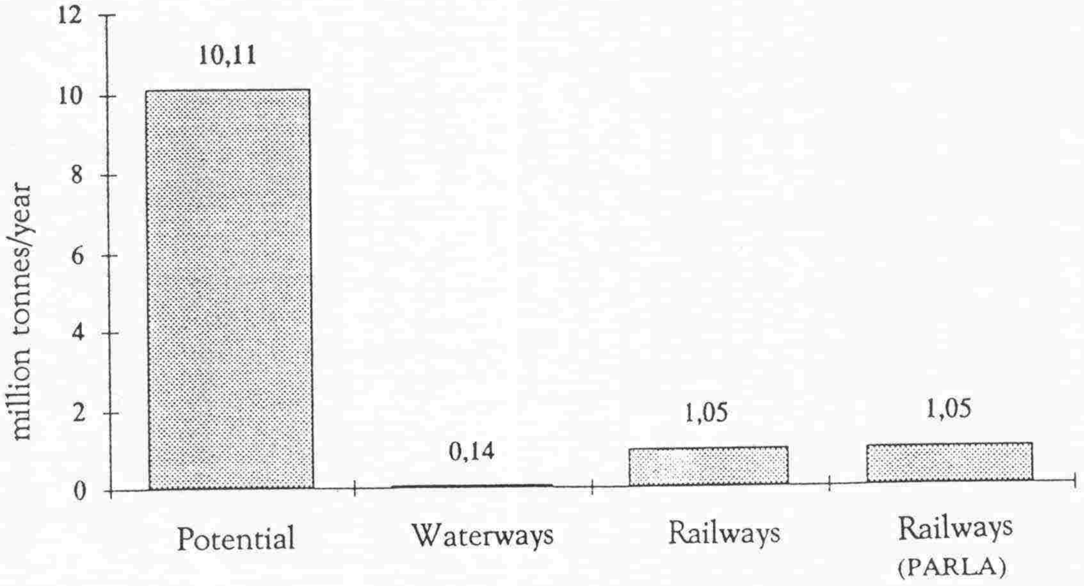


Wood raw material

The wood raw materials have a theoretic potential of about 26 million tonnes per year. Of this amount, based on the cost of transport, about 3.3 million tonnes would be suitable for waterways transport and about 3.1 million tonnes for railways. The floating volumes would be about 3.2 million tonnes and the volume transported by barges about 0.1 million tonnes. The distribution of the wood raw material volumes allocated for floating in the different water systems is presented in the figures in Appendix 3. The volumes suitable for barge transport would be on the coast between Turku-Vaasa. The floating flows of the 1989 actual raw wood transports are presented in Appendix 7.

For comparison, a study that did not include the floating option was done for wood raw materials. Barge transports were possible in addition to road and railway transports. In this case, the model allocated about 0.23 million tonnes for barge transports and about 4.1 million tonnes for the railways. This indicates that floating has a significant impact on the mode of transportation selected for wood raw material. The results indicate that the wood raw materials is the only goods category in which the railways and waterways are competing for the same goods flows.

TRANSPORT VOLUME



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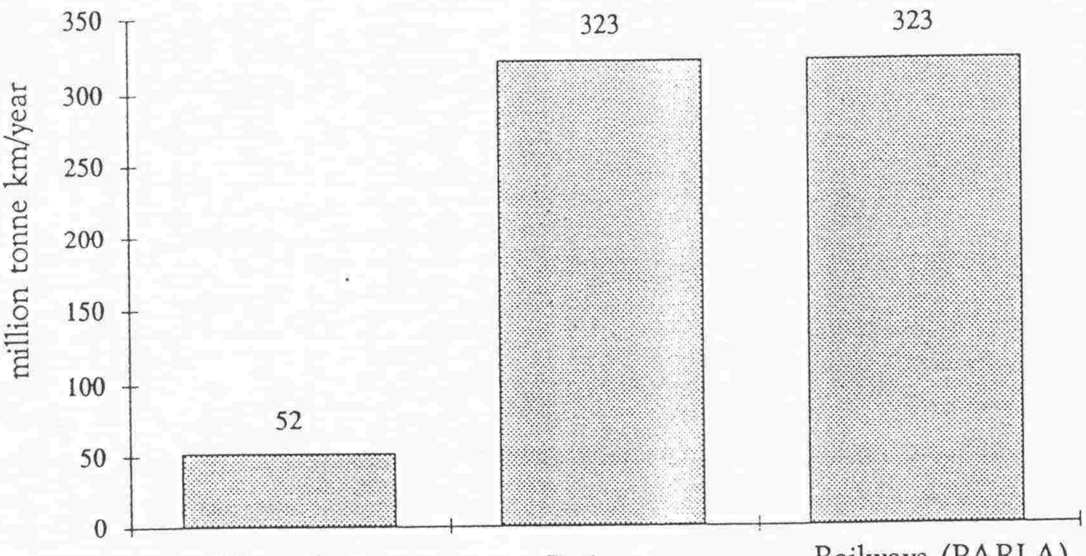
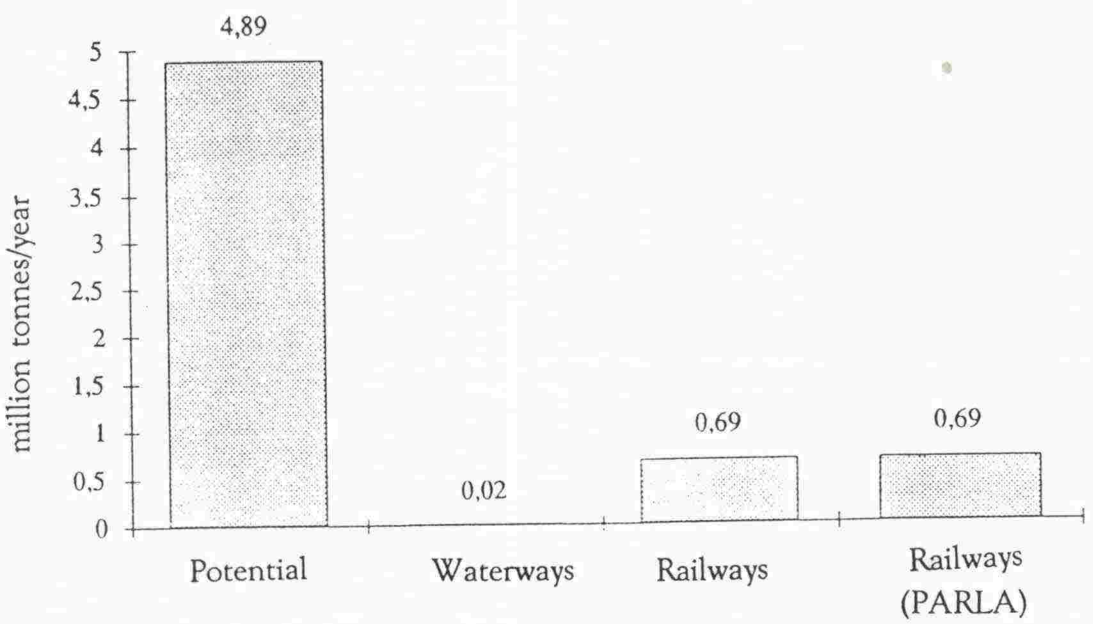


Mineral products

There is a theoretic potential of slightly over 10 million tonnes per year to be transferred from trucks to other modes of transportation. Of this amount, based on the cost of transport, the most economic transport allocation would be 0.14 million tonnes by barge and 1.05 million tonnes by train. The barge transports would be centralized on the coast between Rauma and Kaskinen and between Kaskinen and Turku. Barge and rail transports do not compete for the same mineral product flows.

TRANSPORT VOLUME



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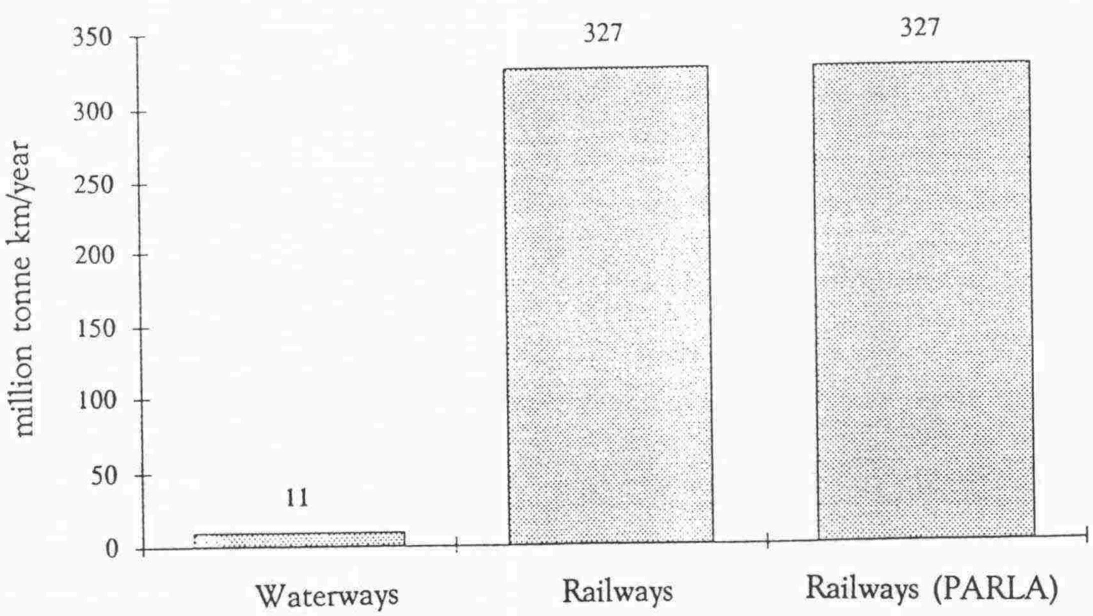


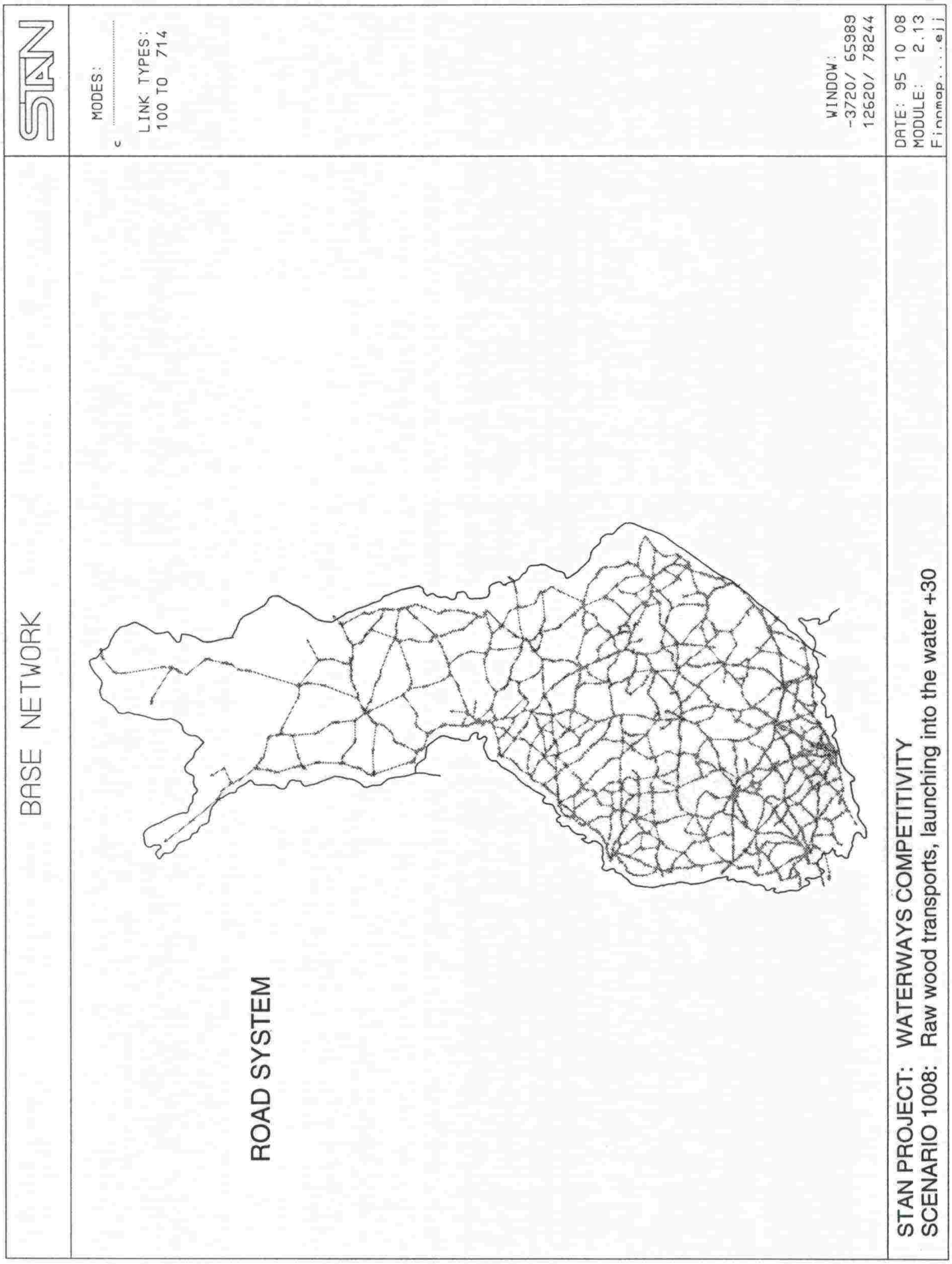
Metal industry products

The theoretical potential of metal industry products would only be about 5 million tonnes per year, but the transport distances are relatively long. Of this volume, the model allocated 0.69 million tonnes to the railways and 0.02 million tonnes to the waterways, i.e a total of about 15%. The metal industry products allocated to the waterways would be barge transports between Helsinki-Rauma.

Forest industry products

The theoretical potential of forest industry products would be about 10.5 million tonnes per year. However, the results indicate that these transports are already allocated in the most economically feasible way in the prevailing transportation system, since the model did not transfer any goods flows to waterway or railway transports.

ROAD SYSTEM


BASE NETWORK
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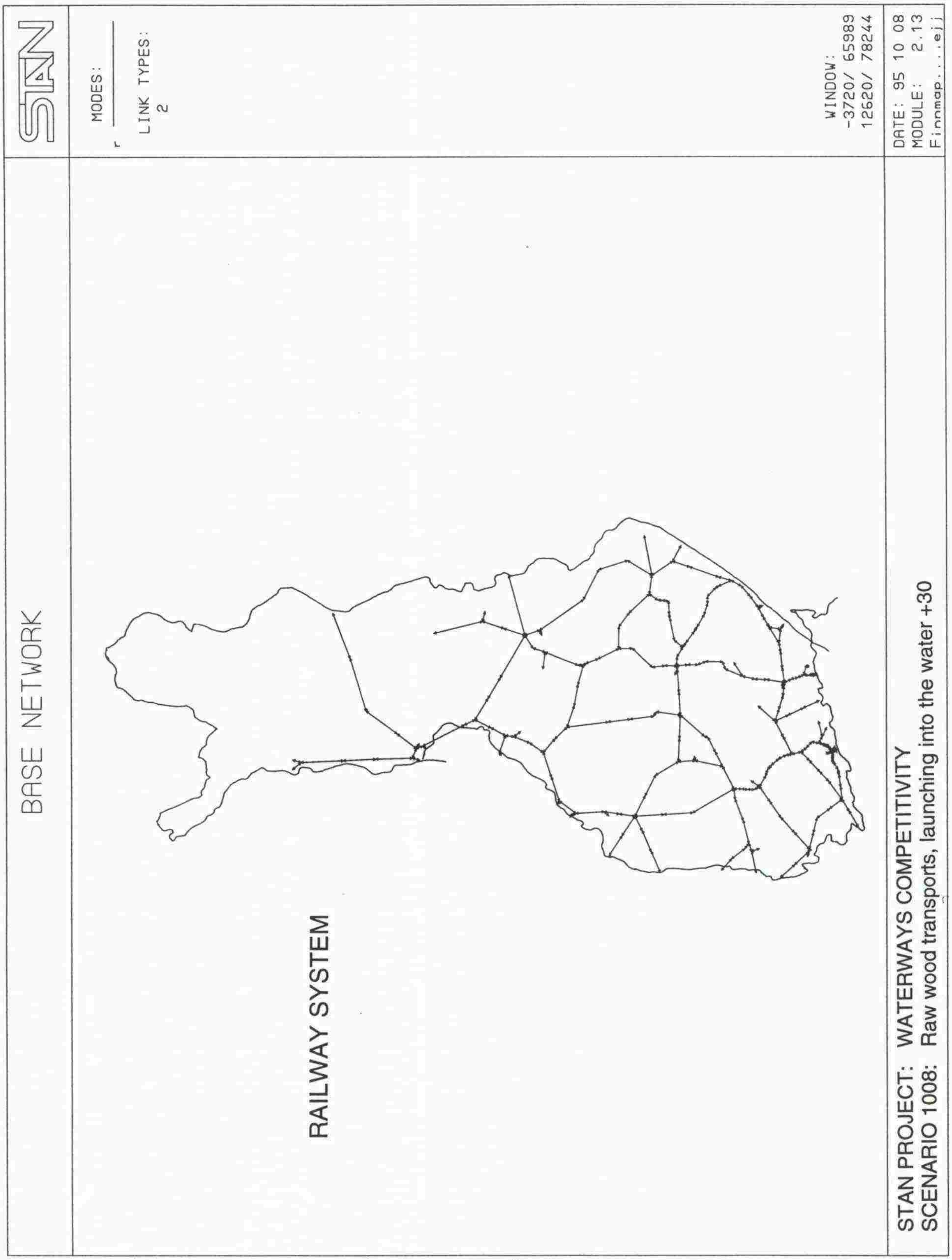
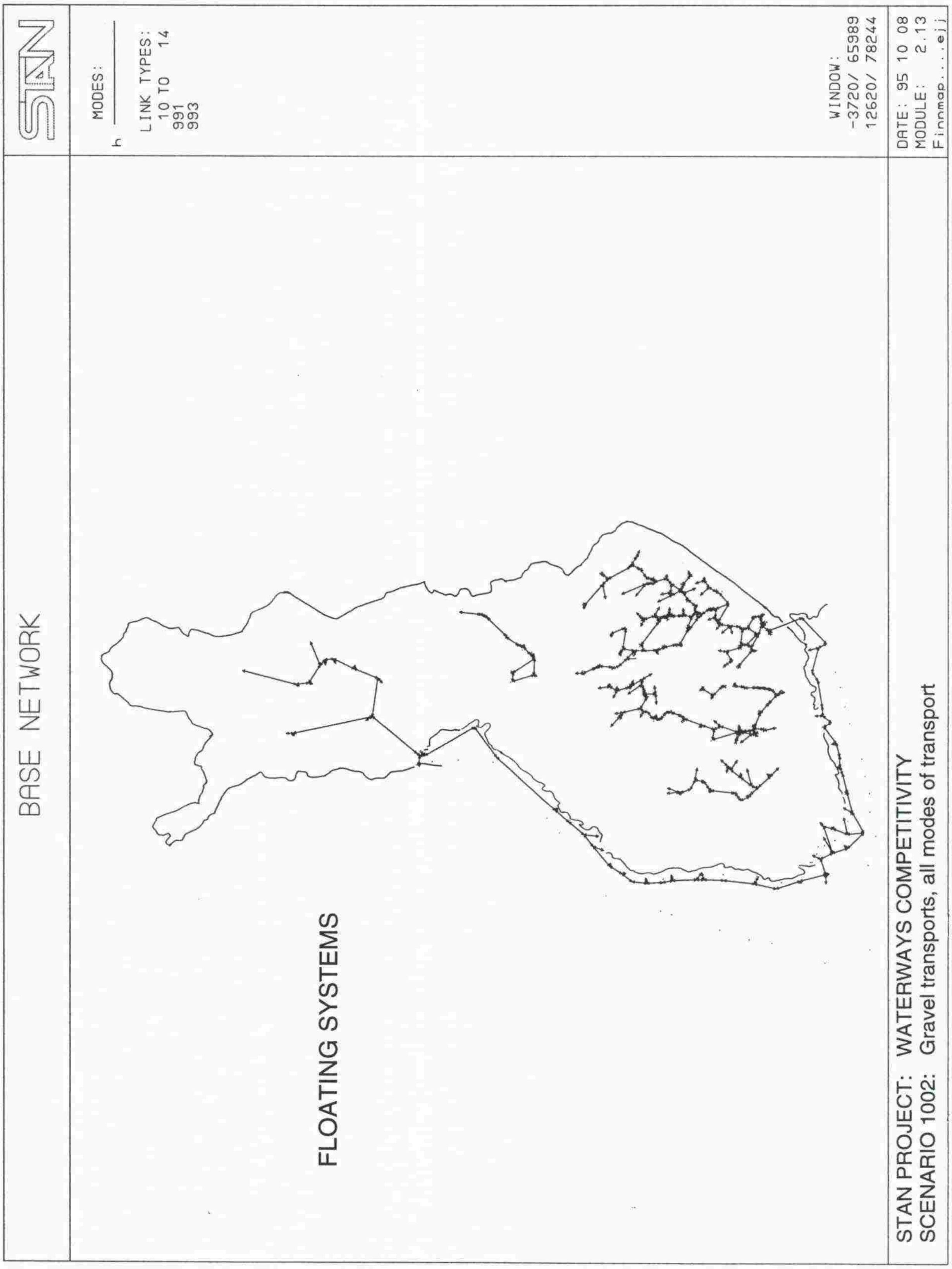
ROAD SYSTEM
STAN PROJECT: WATERWAYS COMPETITIVITY
SCENARIO 1008: Raw wood transports, launching into the water +30

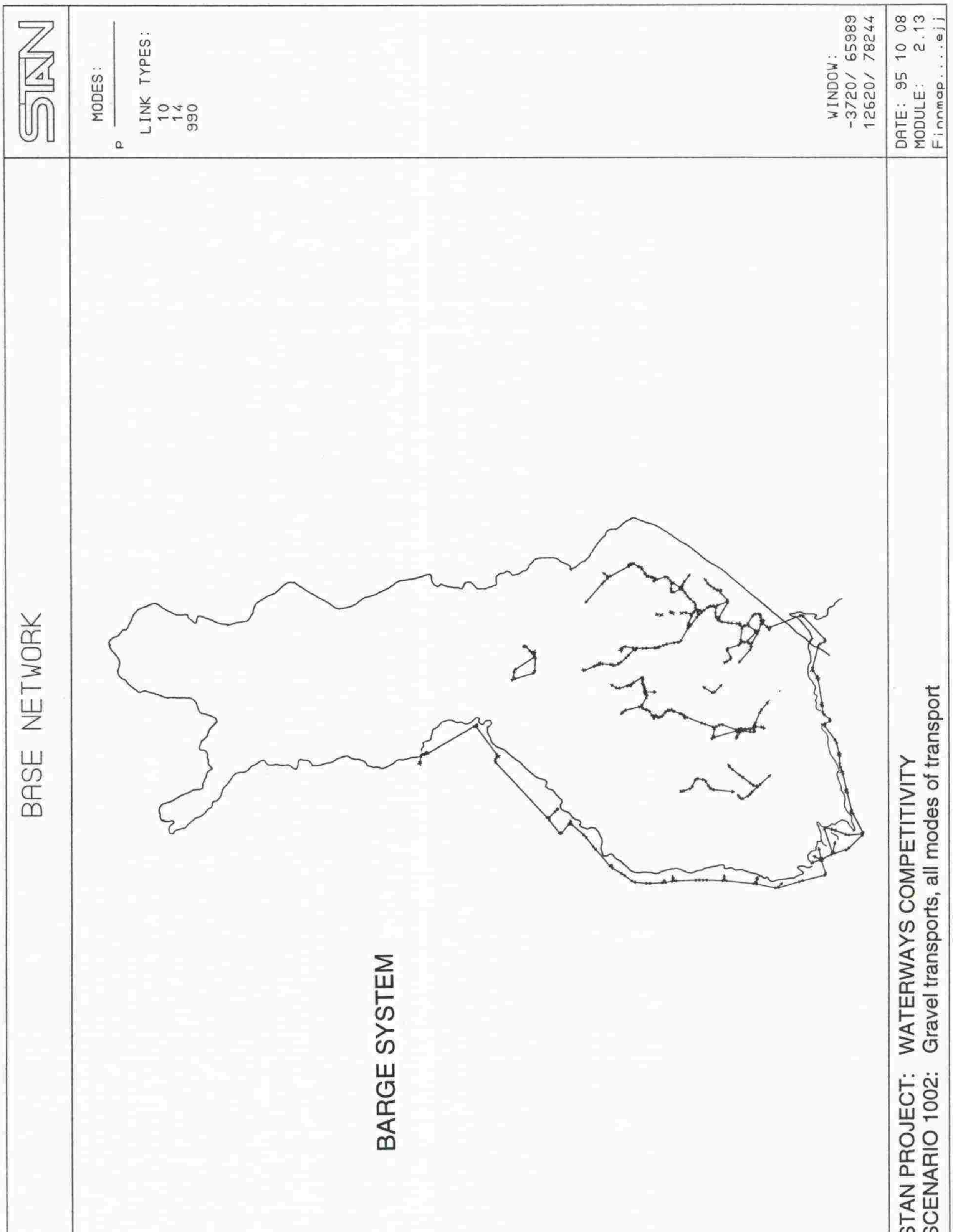
RAILWAY SYSTEM



FLOATING SYSTEMS



BARGE SYSTEM



APPENDIX 2

GOODS CATEGORIES

I GRAVEL, SAND AND OTHER LAND RESOURCES

II WOOD RAW MATERIALS

- logs and pulpwood
- wood chipc, sawdust, wastewood

III FOREST INDUSTRY PRODUCTS

- products of mechanical wood-processing industry
- products of paper industry
- printed matters

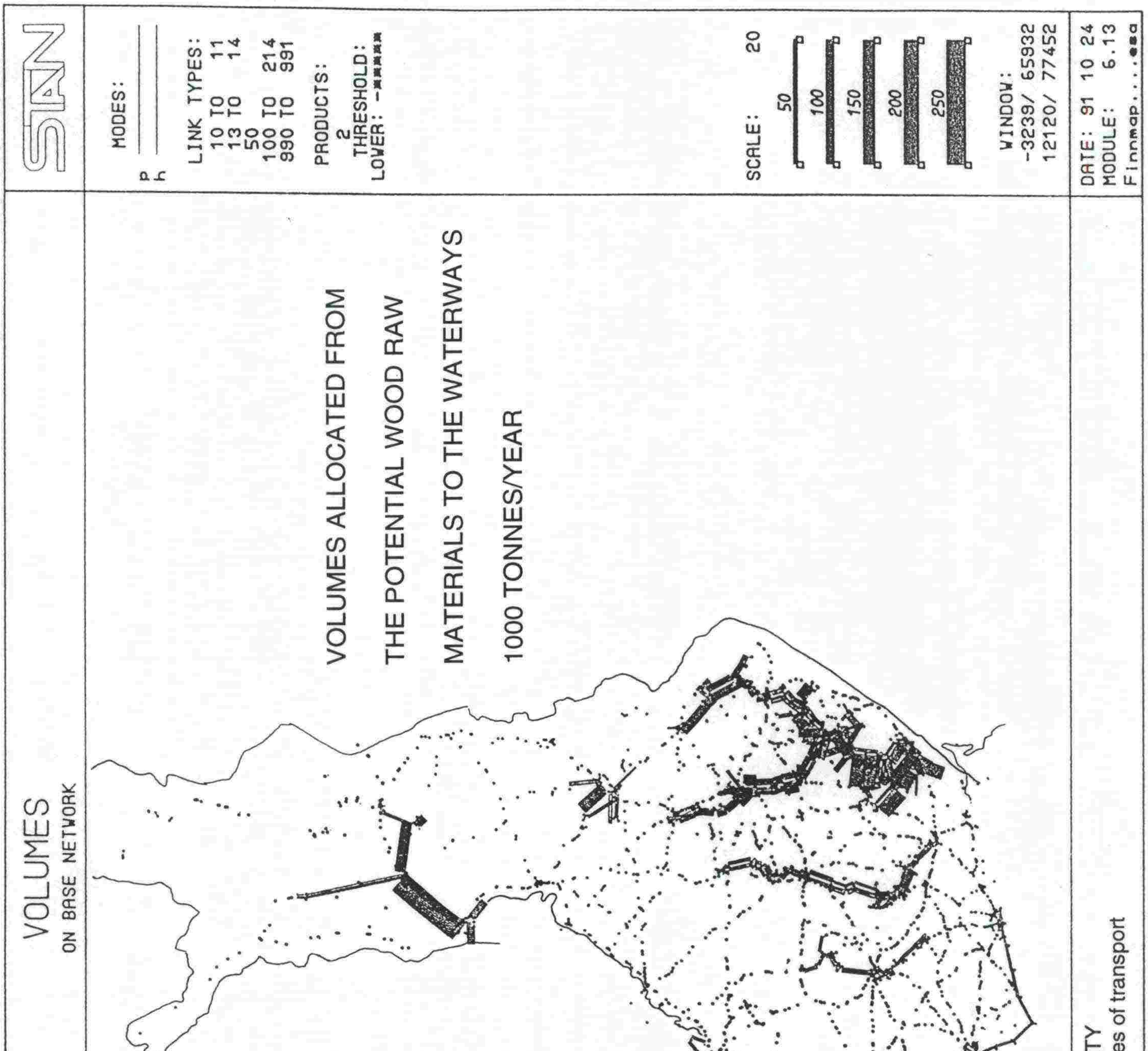
IV MINERAL PRODUCTS

- liquid fuels, oil
- coal, coke
- peat, billet
- cement, lime
- ores, concentrates

V METAL INDUSTRY PRODUCTS

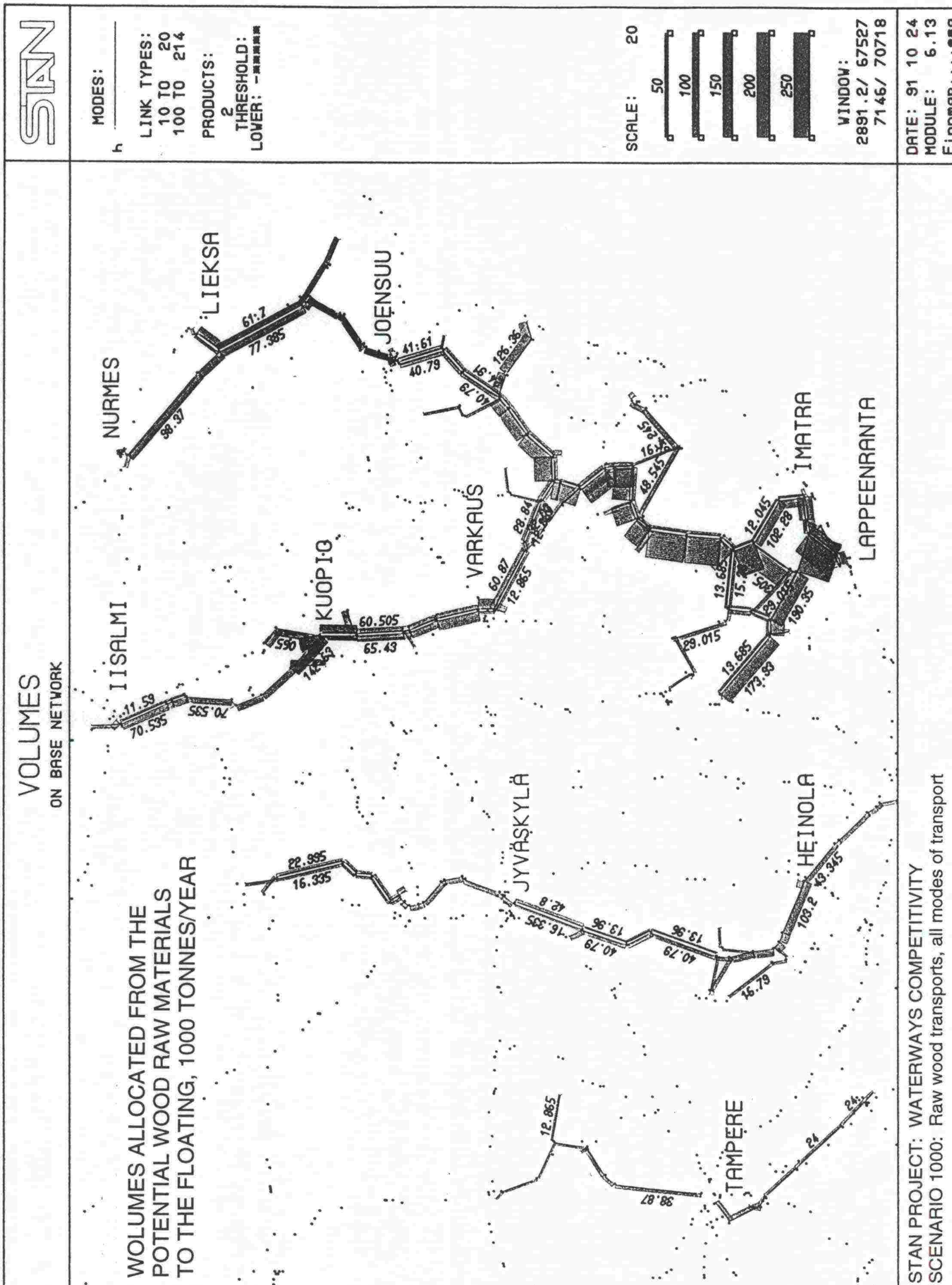
- irons, steels, other metals
- machinery, cars, equipment
- other raw materials of metal industry

Volumes allocated from the potential wood raw materials to the waterways, 1000 tonnes/year



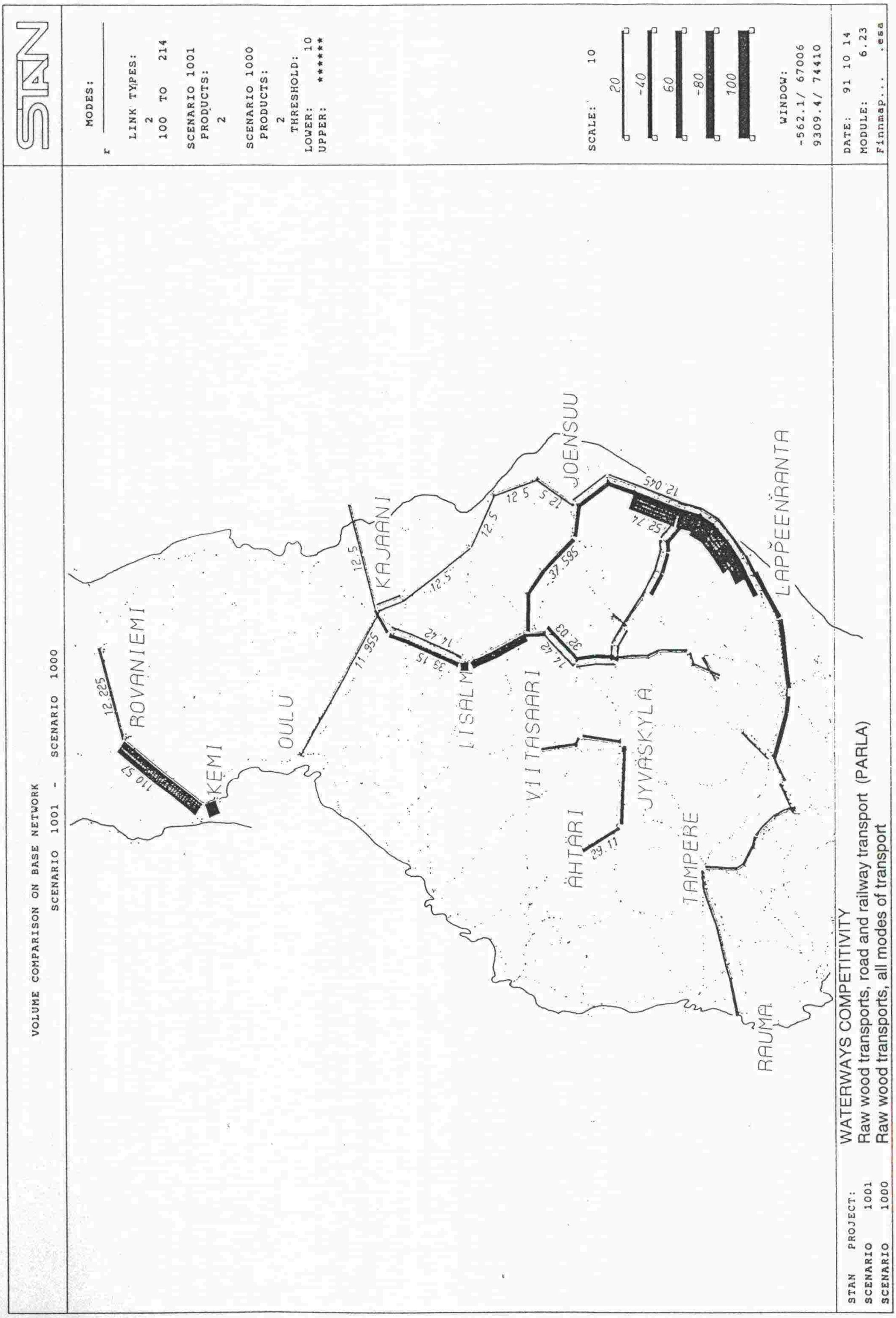
Volumes allocated from the potential wood raw materials to the floating, 1000 tonnes/year

APPENDIX 3/2

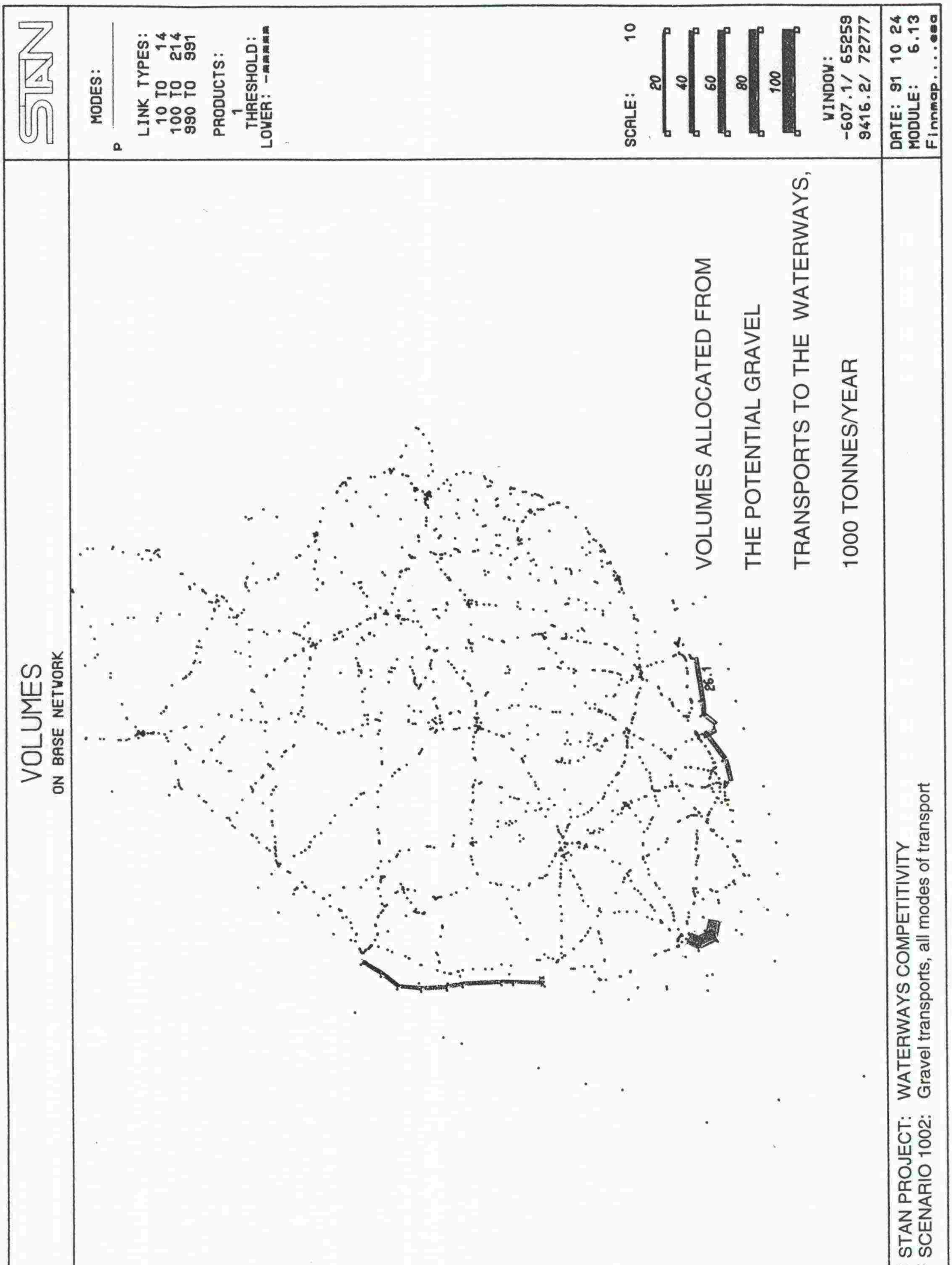


The raw wood volumes (total million tonnes per year) - until now transported by trucks - competed by waterways and railways transports. Flows are presented on railway network (unit 1000 t). Calculations are based on transport costs.

APPENDIX 3/3

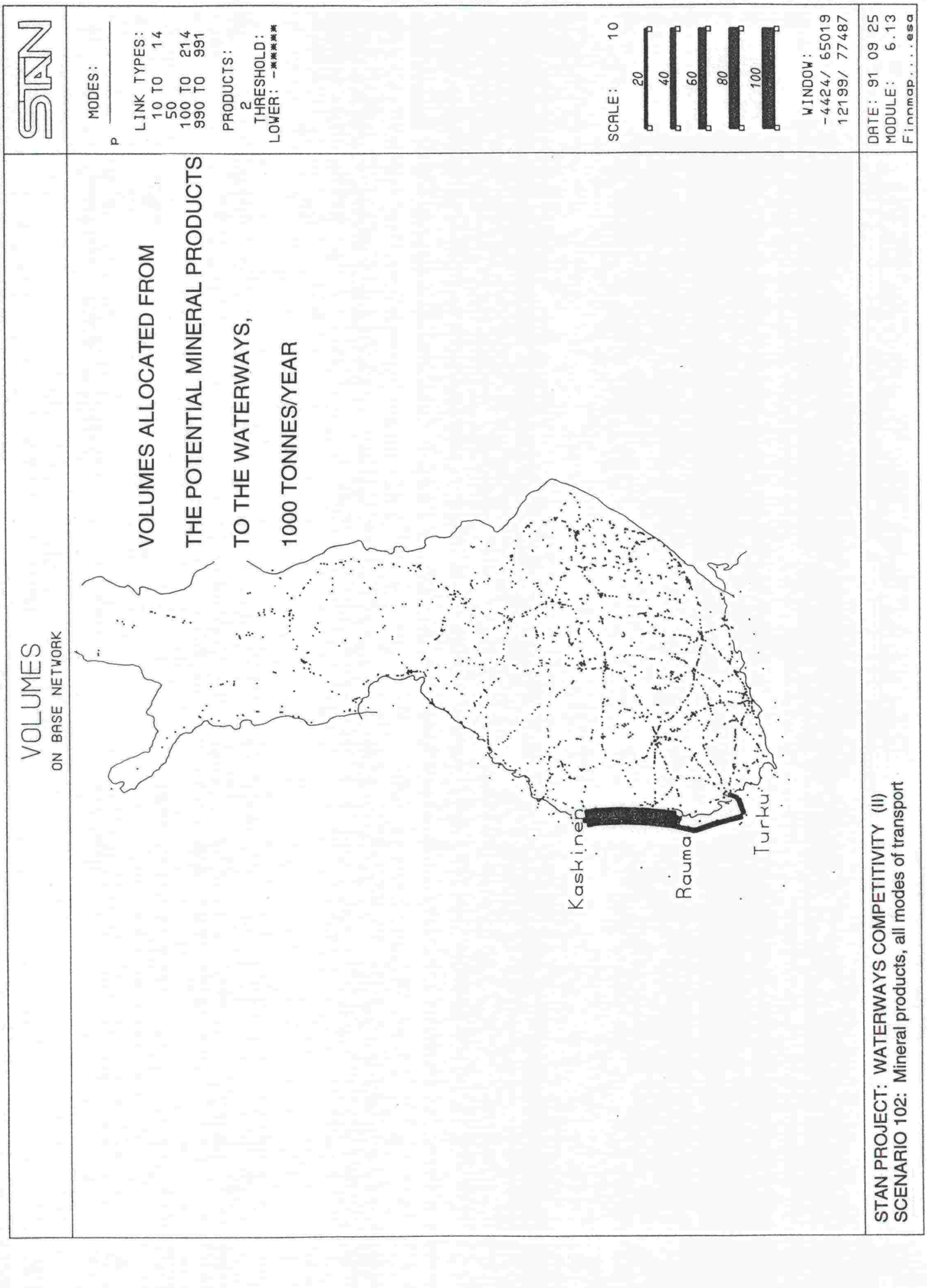


Volumes allocated from the potential gravel transports to the waterways, 1000 tonnes/year



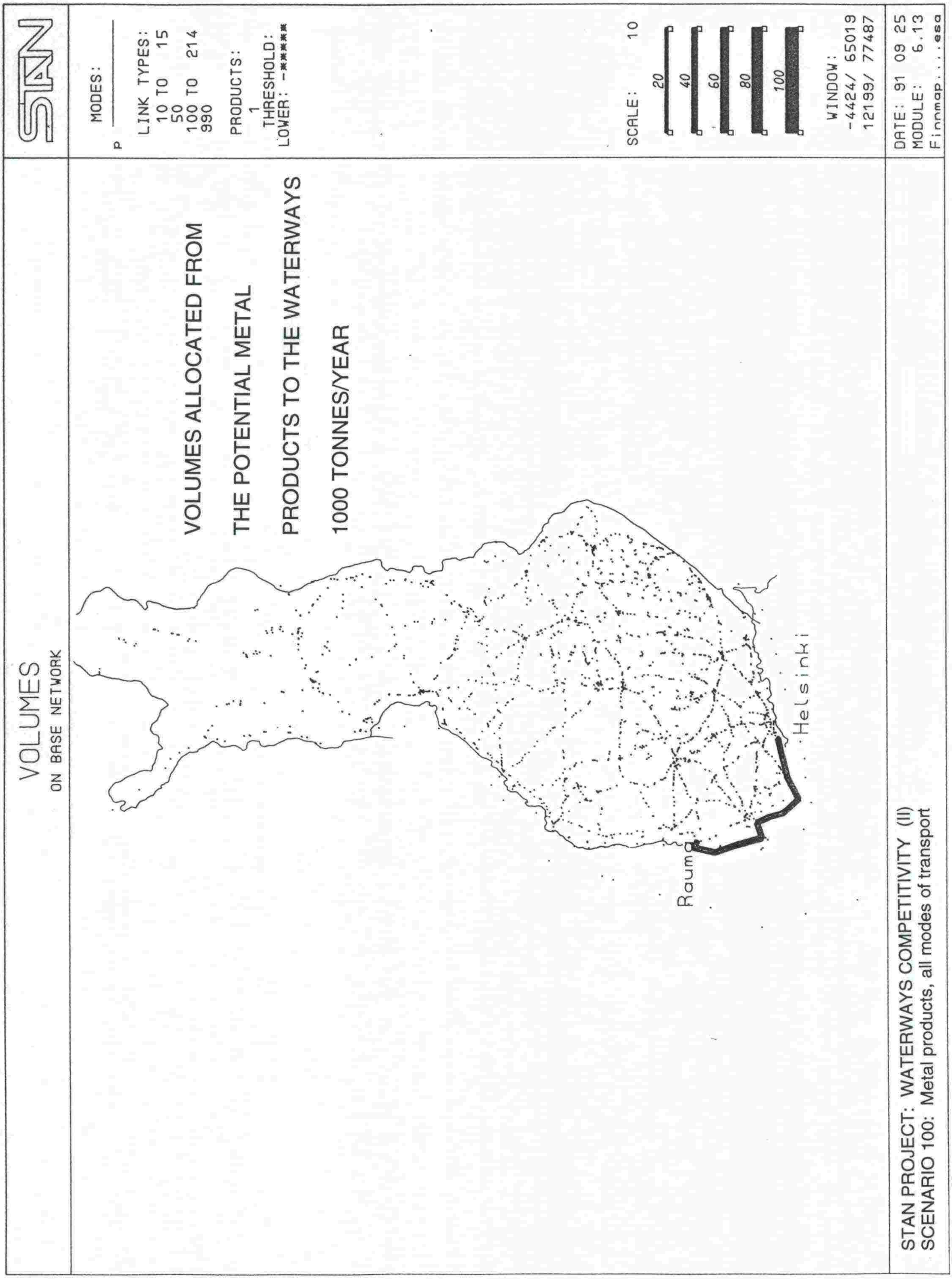
Volumes allocated from the potential mineral products to the waterways, 1000 tonnes/year

APPENDIX 5



Volumes allocated from the potential metal products to the waterways, 1000 tonnes/year

APPENDIX 6



FLOATING FLOWS OF RAW WOOD IN 1989 (million tonnes)